Next Steps for Japan-U.S. Cooperation in Space

by Todd Harrison and Zack Cooper

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Introduction

The space domain is increasingly important to Japan and the United States for both military security and economic prosperity. While the early years of the space era were dominated by the United States and the Soviet Union, today more than 50 counties own and operate satellites and virtually every country relies on space-based capabilities. As a result, the space environment has become more crowded, with 1,265 satellites currently on-orbit.[1] Space has also become a key enabler for the projection of military power, allowing mobile forces to be networked over greater distances and across all regions of the globe. More than 20 nations now have military satellites, making space an important domain for modern military forces.[2]

Threats to Space Assets

As the space domain has become more crowded, it has also become more contested. The Chinese anti-satellite (ASAT) test in 2007 made clear the risks kinetic ASAT weapons pose to civilian and military satellites, producing more than 2,600 pieces of large debris (greater than 10 centimeters) and at least 150,000 pieces of small debris (greater than 1 centimeters), the vast majority of which are in orbits projected to last a decade or longer.[3] Satellites in low earth orbit (LEO), where many imaging satellites reside, are particularly vulnerable to the type of direct ascent kinetic ASAT weapons used in the Chinese test because lower altitudes are easier to reach with missiles and more countries can attain this capability. Attacking satellites at higher altitudes—such as medium earth orbit (MEO) where Global Positioning System (GPS) satellites reside, or geostationary orbit (GEO) where many communications and missile warning satellites are located—requires a larger, more complex missile with multiple stages or a space mine that is launched into orbit and later maneuvered to intercept a target satellite.

Non-kinetic threats, however, such as jamming, high-powered microwaves, and lasing, can threaten satellites in a wide range of orbits, including MEO and GEO. Lasers can be used to blind imaging satellites temporarily, and high-powered lasers can damage satellites by causing parts of the satellite to overheat or by permanently disabling optical components on imaging satellites. A high-powered microwave weapon can be used to damage any unshielded electronics on a satellite, causing computers to reboot or circuits to become overloaded. Jammers work by emitting noise in the same frequency in which the satellite is trying to transmit or receive information, and if the jamming noise is powerful enough, communications to or from the satellite can be blocked.

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[1] Analysis of the Union of Concerned Scientists Satellite Database, data current through January 31, 2015, accessed at: http://www.ucsusa.org/nuclear-weapons/space-weapons/satellite-database.html#.VeRUq_ZVhBc.

[2] Ibid.

[3] "Fengyun-1C Debris: One Year Later," *NASA Orbital Debris Quarterly News*, Vol. 12, Is. 1, January 2008, p. 3, accessed at: http://orbitaldebris.jsc.nasa.gov/newsletter/pdfs/ODQNv12i1.pdf.

The effects of non-kinetic ASAT weapons differ from kinetic ASAT weapons in several ways. Attribution can be difficult with non-kinetic weapons since the source of the attack can be difficult to pinpoint, and the effects of non-kinetic weapons are often fully reversible once the attack ceases. Importantly, non-kinetic weapons do not produce a cloud of orbital debris that can threaten other satellites in similar orbits. Given these attributes, non-kinetic ASAT weapons are particularly worrisome because they could be used prior to the initiation of overt military conflict, effectively creating a "grey zone" dilemma in space where intentions are ambiguous and the risks of escalation and miscalculation are high.

Ongoing U.S.-Japan Space Cooperation

Japan and the United States have increased space cooperation in recent years, both out of commercial interest and defensive necessity. Japan and the United States both rely on highly advanced command, control, communication, computers, intelligence, surveillance, and reconnaissance (C4ISR) architectures, which are vulnerable to attack and disruption. To offset this vulnerability, the allies have sought to improve their cooperation on both commercial and military uses of space.

Japan's new 10-year Basic Plan on Space Policy was issued in January 2015. The updated policy document noted, "The use of outer space is indispensable to maintaining security today… We will engage in space development to directly utilize it for our nation's diplomatic and security policies, as well as for the Self-Defense Forces."[4] To that end, Tokyo agreed to establish a new debris monitoring system and to share data with the United States, as well as to cooperate on Japan's Quasi-Zenith Satellite System (QZSS), a potential complement to the U.S. GPS system. Japan also announced plans to improve its space launch capabilities and to put in orbit an additional eight satellites. Meanwhile, Japan has been upgrading its Japan Aerospace Exploration Agency's research and development mission. Together with efforts to revise the three principles for arms exports and the restrictions on the exercise of collective self-defense, such efforts open the door for deeper collaboration between the allies.

In April 2015, the revised Guidelines for Japan-U.S. Defense Cooperation recognized the need to maintain and strengthen the allies' partnership "to secure the responsible, peaceful, and safe use of space."[5] The two governments reaffirmed their commitment to secure the responsible,

[4] "Abe approves new space policy with profit, security in mind," Japan Times, January 9, 2015, accessed at: http://www.japantimes.co.jp/news/2015/01/09/national/new-space-policy-focuses-security-science/#.VeSbjflViko.

[5] This agreement included efforts to ensure the resiliency of their space systems and enhance space situational awareness cooperation; to provide mutual support; to establish and improve capabilities; to share information about actions and events that might affect the safety and stability of the space domain and impede its use; and to share information to address emerging threats against space systems while pursuing opportunities for cooperation in maritime domain awareness and in space-related equipment and technology that will strengthen capabilities and resiliency. In addition, the Self-Defense Forces and the United States Armed Forces agreed to cooperate and to contribute to whole-of-government efforts

peaceful, and safe use of space as well as enhance space cooperation from a broad, inclusive, and strategic perspective including through the U.S.-Japan Comprehensive Dialogue on Space. Washington and Tokyo also agreed to strengthen the resilience and interoperability of critical space systems, focusing on space-based positioning, navigation, and timing; enhanced space situational awareness; use of space for maritime domain awareness; research and development in space technologies; and use of hosted payloads. Finally, the governments announced support for international efforts to develop transparency and confidence-building measures to encourage responsible actions in, and the peaceful use of, space, such as an International Code of Conduct for Outer Space Activities.[6]

Non-government experts in Washington and Tokyo have also suggested a number of new potential cooperative efforts. The Mansfield Foundation issued a report on space collaboration in April 2015 that suggested a number of steps, including a more formalized Japanese role in the Joint Space Operations Center at Vandenberg Air Force Base in California, bilateral tabletop exercises on space; sharing of maritime domain awareness data collected from space; and increased commercial and defense-related cooperation between U.S. and Japanese space industries.[7] The two governments are also examining bilateral ways to increase space situational awareness (SSA) and expand upon the existing space security trilateral dialogue with Australia.[8]

Given the increasing importance of space-based assets for military and civilian uses and the growing threats to space systems, it is in the mutual interests of both Japan and the United States to expand cooperation and joint development in the space domain. While there are many ways in which Japan and the United States can increase cooperation in space, two key areas of cooperation should be explored in the near term: space stewardship and hosted payloads for military applications.

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in utilizing space in such areas as: early-warning; ISR; positioning, navigation, and timing; space situational awareness; meteorological observation; command, control, and communications; and ensuring the resiliency of relevant space systems that are critical for mission assurance. "The Guidelines for Japan-U.S. Defense Cooperation," April 27, 2015, accessed at: http://www.mod.go.jp/e/d_act/anpo/shishin_20150427e.html.

[6] The White House, "Fact Sheet: U.S.-Japan Cooperation for a More Prosperous and Stable World," April 28, 2015, accessed at: https://www.whitehouse.gov/the-press-office/2015/04/28/fact-sheet-us-japan-cooperation-more-prosperous-and-stable-world.

[7] "U.S.-Japan Space Forum: Mid-Term Objectives and Near-Term Priorities for Japan-U.S. Space Cooperation," The Maureen and Mike Mansfield Foundation, April 2015, accessed at: http://mansfieldfdn.org/mfdn2011/wp-content/uploads/2015/04/Mansfield-Foundation-US-Japan-Space-Forum-Publication-1.pdf.

[8] Frank A. Rose, "Security in the Asia Pacific Region and U.S.-Japan Space Cooperation," Remarks at conference hosted by the Elliott School of International Affairs, George Washington University, February 13, 2015, accessed at: http://www.state.gov/t/avc/rls/2015/237490.htm.

Space Stewardship

Proper stewardship of the space domain is in the interest of all responsible space-faring nations. As the 2007 Chinese ASAT test made clear, the space domain is inherently global and the actions of one nation in space can adversely affect all other nations. For example, the International Space Station has been forced to adjust its orbit on multiple occasions to dodge debris from the Chinese ASAT test,[9] and a small Russian satellite was believed to be hit by the same debris field in 2013, which in turn produced more debris.[10] Accidental collisions in space are also an issue, as highlighted by the 2009 collision between an inoperable Russian Cosmos satellite and a functioning Iridium satellite. These two events, the 2007 Chinese ASAT test and the 2009 accidental collision, produced about half of all the debris currently tracked in LEO and more than ten times as many trackable pieces of debris than there are satellites in LEO.[11]

Two specific steps Japan and the United States could take to improve stewardship of the space domain are to jointly develop and deploy additional space situational awareness satellites and on-orbit servicing vehicles. Space situational awareness satellites allow operators to identify and track smaller objects than Earth-based tracking stations allow. This is particularly important in the GEO belt, where objects orbit roughly 36,000 kilometers above the equator and can be difficult to find with even the largest ground-based telescopes available, due to their small size and long distances involved.

The first Japan-U.S. Comprehensive Dialogue on Space noted the need to cooperate on SSA, and the second Comprehensive Dialogue on Space reaffirmed this goal.[12] Cooperation to date has focused on data sharing from existing SSA assets, but an important next step in this cooperation is to begin jointly building and deploying SSA satellites. The United States has started an effort known as the Geosynchronous Space Situational Awareness Program (GSSAP), and the first two satellites were launched in 2014. Jointing developing and deploying systems like GSSAP would increase the coverage and number of SSA assets on-orbit, allow more objects to be identified and tracked, reduce redundancy in technical development efforts, and increase the resiliency of SSA capabilities.

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9 Joel Spark, "ISS Dodges Chinese ASAT Debris," *Space Safety Magazine*, January 30, 2012, accessed at: http://www.spacesafetymagazine.com/news/iss-forced-dodge-chinese-asat-debris/.

10 T.S. Kelso, "Chinese space debris may have hit Russian satellite," *AGI Blog*, accessed at: http://blogs.agi.com/agi/2013/03/08/chinese-space-debris-hits-russian-satellite/.

11 "An update of the FY-1C, Iridium 33, and Cosmos 2251 Fragments," *NASA Orbital Debris Quarterly News*, January 2013, accessed at: http://orbitaldebris.jsc.nasa.gov/newsletter/pdfs/ODQNv17i1.pdf.

12 See "Joint Statement from the First Meeting of the Japan-U.S. Comprehensive Dialogue on Space," *Media Note from U.S. Department of State*, March 11, 2013, accessed at: http://www.state.gov/r/pa/prs/ps/2013/03/205939.htm and "Joint Statement from the Second Meeting of the Japan-U.S. Comprehensive Dialogue on Space," *Media Note from U.S. Department of State*, May 12, 2014, accessed at: http://www.state.gov/r/pa/prs/ps/2014/05/225990.htm.

While identifying and tracking debris is important, avoiding the production of additional debris from accidental collisions is also an important area in which the United States and Japan can increase cooperation. The 2009 collision between an Iridium satellite and an inoperable Cosmos satellite highlights the need for an on-orbit servicing system that can move dead satellites to safe orbits or, if possible, de-orbit them to prevent accidental collisions and the creation of additional debris. The Defense Advanced Research Projects Agency (DARPA) currently has a project underway to develop an on-orbit servicing vehicle specifically designed to move cooperative satellites in the GEO belt.[13] Japan is also working on an experimental approach using a magnetic net to collect and remove small objects in orbit.[14] By working together and leveraging the knowledge and technology each country has already developed, the alliance could speed the much-needed deployment of operational systems for on-orbit servicing and debris mitigation.

Hosted Military Payloads

While improved stewardship of the space domain benefits all space users, the use of hosted payloads for military applications could greatly enhance the defensive military capabilities of both Japan and the United States. Hosting a payload on a satellite means modifying a payload developed for one type of satellite and to be carried as a secondary (or tertiary) payload on another satellite. Three specific opportunities stand out as ideal candidates for the use of hosted payloads between Japan and the United States: protected satellite communications, jam-resistant M-code GPS, and infrared missile warning payloads.

The United States currently plans to field a constellation of six Advanced Extremely High Frequency (AEHF) satellites for protected satellite communications. The payloads on these satellites are designed to allow both tactical and strategic users to maintain connectivity even in the presence of severe interference, such as intentional jamming. The current six-satellite constellation, however, does not have sufficient capacity to support the large number of tactical users that would likely need protected communications in a contested communications environment. The addition of AEHF-derived hosted payloads to the constellation would expand the constellation's capacity to support more tactical users and present an opportunity to bring Japan into the program.

AEHF-derived hosted payloads have already been used on a pair of U.S. polar-orbiting satellites to extend coverage to the arctic region, known as the Enhanced Polar System (EPS). A similar approach could be used to host AEHF payloads on one or more Japanese satellites. The host satellites could be military or civilian, provided they have sufficient size, weight, and power to

[13] See "Wanted: Insights to Guide Creation of Robotic Satellite-Servicing Capabilities in Geostationary Earth Orbit," *DARPA Press Release*, September 3, 2014, accessed at: http://www.darpa.mil/news-events/2014-09-03.

[14] See "Japan's huge magnetic net will trawl for space junk," *New Scientist*, January 22, 2014, accessed at: https://www.newscientist.com/article/mg22129534-800-japans-huge-magnetic-net-will-trawl-for-space-junk/.

support the hosted payload. Hosting an AEHF payload on a Japanese satellite would also enhance interoperability between U.S. and Japanese forces and improve the capabilities of Japanese forces to operate independently in a more contested communications environment.

Another opportunity to increase cooperation in space using hosted payloads is for positioning, navigation, and timing. The U.S. GPS constellation is currently deploying a new capability, known as the M-code signal, which provides a more jam-resistant encrypted signal for military users. The M-code signal allows military users to lock on to a GPS satellite without initially using the more vulnerable civilian signal, and spot beam antennas can increase the power of the M-code signal in a jamming environment to reduce the effective radius of jammers. A GPS payload with these capabilities could be hosted on future versions of Japan's Quasi-Zenith Satellite System. The four-satellite QZSS constellation is being launched into an inclined, slightly eccentric geosynchronous orbit so that at least one satellite will be nearly directly over Japan at any given time. Including M-code capabilities on these satellites would improve the coverage and resiliency of the new jam-resistant M-code signal in the Asia-Pacific region.

Missile warning is also an important area in which hosted payloads could facilitate better cooperation between Japan and the United States. The backbone of the United States' missile warning satellite constellation is the Space-Based Infrared System (SIBRS). The SBIRS constellation plans to launch four satellites in GEO and two in a highly elliptical polar orbit for coverage of the arctic region. In 2011, the United States launched an infrared payload hosted on a commercial satellite, known as the Commercially Hosted Infrared Payload (CHIRP), to prove the concept of using hosted payloads to augment existing missile warning systems using a wide-field infrared sensor. During 27 months of operations, CHIRP collected data on more than 70 launches and 150 other infrared events.[15] Similar infrared payloads could be hosted on Japanese satellites to enhance missile warning capabilities over the Asia-Pacific region.

Conclusion

Increasing Japan-U.S. cooperation in space by improving space stewardship and using hosted payloads for military applications would enhance the resilience of the alliance's space systems and help deter aggression in space. The areas of cooperation outlined here, while not exhaustive, would leverage the technological and industrial capabilities of both nations for mutual advantage. Improving space stewardship will help promote the peaceful and responsible use of space by all nations and maintain a safe operating environment for civilian and military users alike. Cooperation on hosted payloads for protected communications, M-code GPS, and missile warning will enhance the military capabilities of both nations while being strictly defensive in nature. Moreover, bilateral cooperation on military hosted payloads will complicate the planning of potential adversaries because an attack on a host satellite or a hosted payload would be

[15] "Air Force Commercially Hosted Infrared Payload Mission Completed," *Air Force Press Release*, December 6, 2013, accessed at: http://www.losangeles.af.mil/news/story.asp?id=123373357.

regarded as an attack against the space assets of both nations and thus run the risk of horizontal escalation. Increased cooperation in space can be a strategic advantage for the alliance and a cornerstone of the U.S. rebalance to the Asia-Pacific region.